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ANALYSIS OF A STEEL NETWORK TOWER CONSIDERING LATERAL FORCES USING ANALYSIS TOOL STAAD.PRO

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Abstract:

A Network tower or cell base station is a phone emforceed cell phone site where receiving wires and electronic correspondences hardware are set regularly on a radio pole, tower, or other raised design to make a cell (or contiguous cells) in a cell organization. The raised design normally upholds a radio wire and at least one arrangements of transmitter/beneficiaries handsets, computerized signal processors, control gadgets, a GPS beneficiary for timing, essential and reinforcement electrical force sources, and protecting.
The proposed study is a static analysis of network tower structure 25 m tall, fixed to the earth. It contains facts necessary for a need to create and apply tower beam structures. Beam elements i.e. bracings and horizontal members were used to design a model and a static analysis will be performed in finite element program Staad.pro. Four types of loading conditions will be proposed to consider i.e. dead load, live load, seismic as per zone II and wind pressure 39 m/s. The static analysis will be applied to find maximal deformations and the displacement caused by lateral force and self-weight. Finally, stability and suitability of the whole construction was considered.

Keywords: Tower, seismic load, wind pressure, structural analysis, stability, displacement.

Introduction:

In the course of recent years, the developing interest in remote and broadcast correspondence has prodded a sensational expansion in correspondence tower development and upkeep. Numerous businesses and correspondences request towers for an assortment of purposes. A portion of the utilization of steel towers are Microwave transmission for correspondence, Radio transmission, Television transmission, Satellite gathering, Air traffic signals, Floodlight stands Meteorological estimations, Oil penetrating poles, Overhead water tanks, Force transmission lines and so on The quickest developing media transmission market has expanded the interest for steel towers. Disappointment of such constructions is a significant concern.
India has an enormous populace dwelling everywhere on the country and the versatile organization for correspondence and web is a need of this populace makes a prerequisite of huge organization pinnacles and conveyance framework. Additionally, the aura of the essential assets for signal age for example recipient and transmitter, are allowed to the pinnacle. An organization tower is an incorporated framework comprising of a conveyor subsystem, a ground wire subsystem and one subsystem for every class of the help structure. Mechanical backings of pinnacles address a critical part of the expense of the line and they assume a significant part in the solid sign transmitter. They are planned and developed in a wide assortment

of shapes, types, sizes, setups and materials. The supporting design at the base is the R.C.C balance bed which is for the most part confined balance type or relies on the type of soil.

In this study we will consider sections as per (Indian) Steel table. Steel is one of the most widely used material for construction in the world .The inherent strength, toughness and high ductility of steel are characteristics that are ideal for seismic design. To utilize these advantages for seismic applications, the design engineer has to be familiar with the relevant steel design provisions and their intent given in codes.

Objectives of the Study

The primary objectives of this study are as follows:

1. To determine the utilization of different sections in horizontal and diagonal members.
2. To determine the effectiveness of analysis tool Staad.pro in optimization of steel sections as per loads.
3. To analyze a steel network tower for seismic and wind load as per Indian standard provisions.

Literature review

UğurAlbayrak and LoaiMorshid (2020)the essential target of the research was to survey the affectability of commonplace Transmission Line (TL) pinnacles to tremor loads, retrofit a current steel grid tower utilizing another segment Center To Center (CTC). In this examination, a limited component model of a delegate 154 KV transmission tower in Turkey was performed utilizing a bunch of 10 recorded tremor ground developments. The four-legged square TL tower was dissected and intended for Turkey, Eskisehir seismic zone considering 42.95 m stature utilizing limited component (FE) programming. Accordingly, another segment Center to Center (CTC) type has been planned and the bombed areas have been supplanted with a planned segment utilizing the SAP2000 segment structure. For the 154 kV transmission towers, the locking created in the steel individuals is further plausible to happen to steel segments in the pen (top piece) of the pinnacles. A relationship has been resolved between the transmission tower tallness and the seismic weakness for transmission towers.

The outcomes expressed that a load of disappointment expanded in the wake of retrofitting. The retrofitting strategy was viable and simple to be led in fields. Impediments of the flow research, which are the impact of association plan boundaries, bolt course of action, properties of the material surface, material strength, and force esteems, on the association model.

RenjuChandran and Linda Ann Mathew (2016)in the exploration paper, the primary strength of microwave transmission tower with various steel area (I, C and round) was examined under seismic loading conditions utilizing ANSYS and the best steady steel segment was researched. The pinnacle was displayed as a steel structure. For the static examination, the heaps considered were a dead heap of satellites and wind load. CATIA V5 and ANSYS programming were utilized for demonstrating. CATIA V5 was utilized to adhere to a meaningful boundary model of the pinnacle then the line model is traded to ANSYS, at that point properties and load were allocated. I area, channel segment and a ground segment for stable microwave tower were examined utilizing ANSYS programming.

From the seismic examination, the relocation graph and stress dispersion chart of the microwave tower was acquired. The most extreme disfigurement and greatest pressure got for the round area were less. Along these lines, it was reasoned that the round segment is the most steady steel area The subsequent stable segment noticed was the channel segment. At long last, reasoned that the round area is the most steady segment and the channel segment is the steady segment.

Ankushkumarjain et.al (2016)in the examination paper, three distinct models were viewed as specifically three-pivoted telecom pinnacle of point with x propping, three pivoted media transmission pinnacle of cylinder area with x supporting and three-pivoted telecom pinnacle of point with v propping. The targets of the examination were correlations of shear force, bending moment, redirection, pressure and pressure of three cases.

The results derived from the investigation stated that Tube section is more efficient compare to X bracing with angle and V bracing of angle. The X bracing is more efficient compare to V bracing. The Shear force is 20% more in bracing telecommunication tower compare to V bracing telecommunication tower. V bracing media transmission tower is 21 % more proficient in pressure contrast with X supporting telecom pinnacle of point area and cylinder segment of X bracing. V supporting media transmission tower has 25 % more ductile pressure contrast with X propping telecom pinnacle of point area and cylinder part of X bracing. The wind examination results showed that independent of the pinnacle tallness displaying system doesn't fundamentally influence the uprooting design, especially most extreme sidelong removal at the highest point of the pinnacle. Pivotal pressure is more dominating in the investigation and plan of the tower.

Table 1: Geometrical description

Details of Tower	Dimension
Height of Tower	45m
Height of Slant portion	38m
Height of Straight portion at the top of a tower	7m
Base width	6.5m
Top width	1.5m
Angle section upto 38m	110 x 110 x 15 mm
Angle section above 38m	70 x 70 x 10 mm

Step-1: To prepare a literature survey related to our study.

Literature Survey was ready for the past examination embraced to date and weaknesses were recognized on which further exploration should be executed. This above and beyond managed to introduce the use of Telecom Steel Tower.

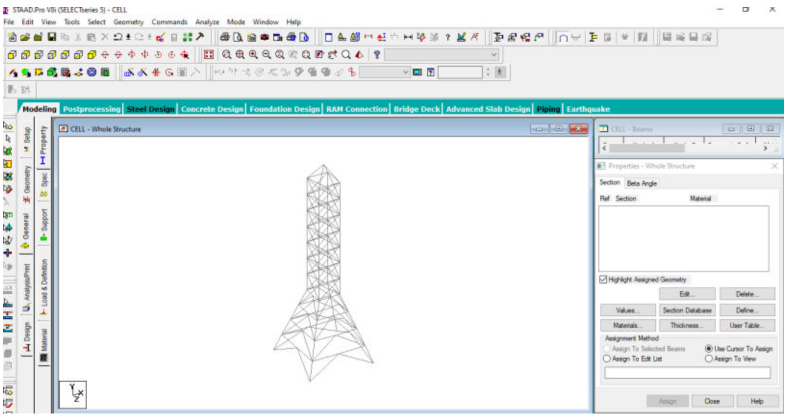

Fig 1 Modelling of tower using nodes.

Step 2 Defining properties of the material

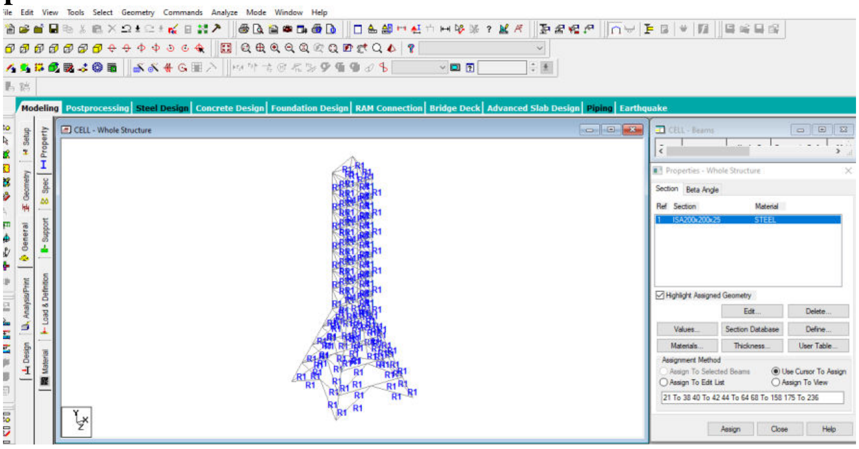

Fig 2 Assigning Section and Material Properties assigning Plate Element Thickness

Step-4 Assigning Fixed Support at the bottom of the structure

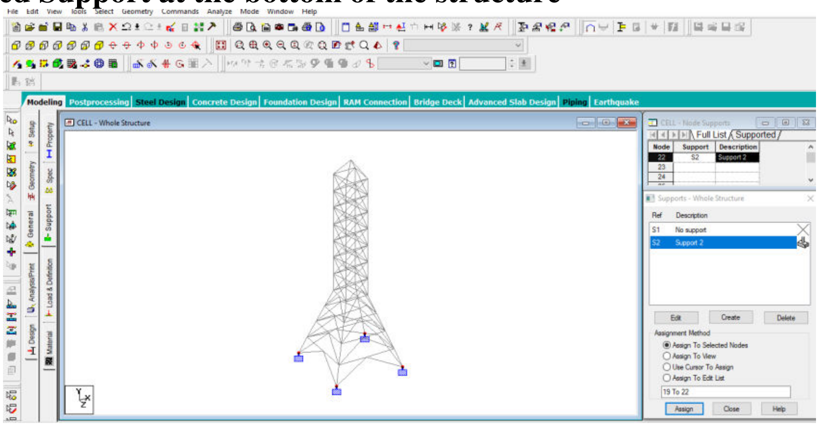

Fig 3 Assigning Fixed Support at the Bottom of the four legged tower

Step-5 Assigning Primary Loading Condition
Self Weight

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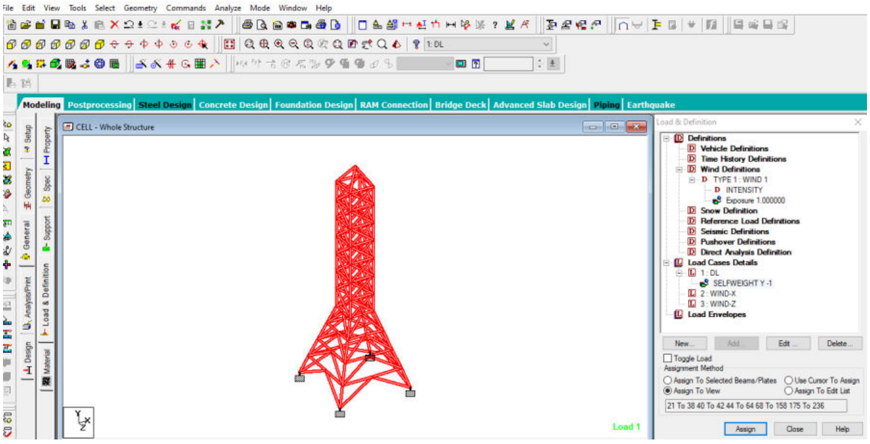


Fig 4 Assinging Self Weight to the structure

Wind Load X Direction

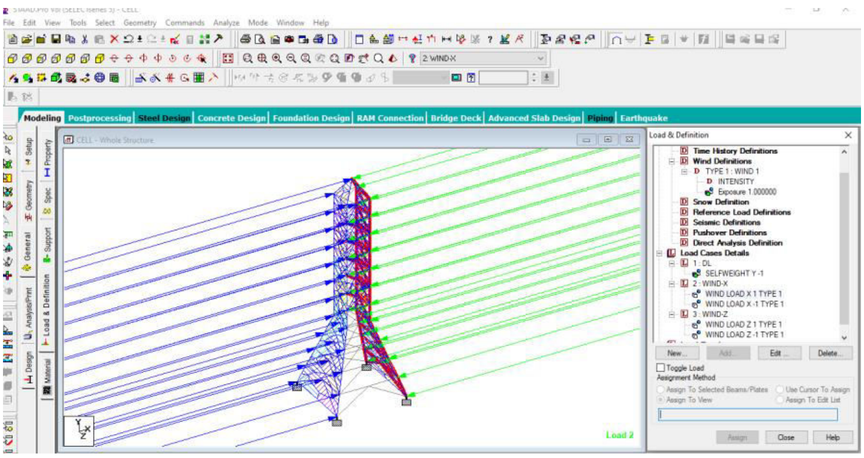


Fig 5 Assigning Wind Load to the Structure

Wind Load in Z Direction

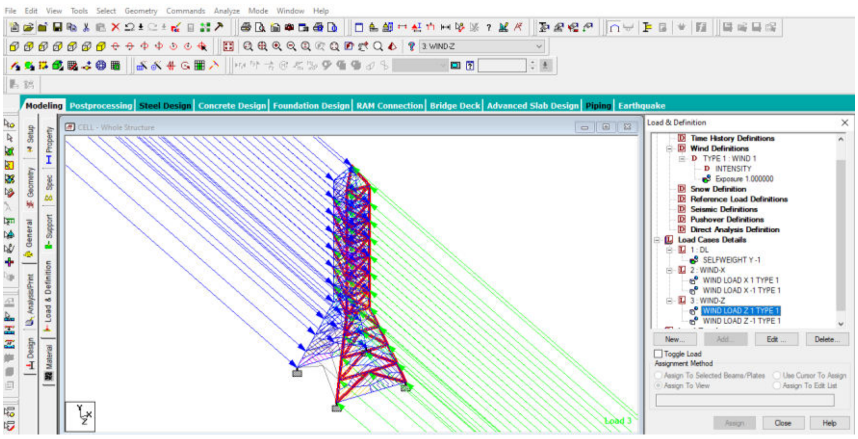


Fig 6 Assigning wind load in Z Direction

Step-6 Assigning Seismic Loading conditions as per IS: 1893-2016

Seismic Loading condition was assigned with conditions with different zone considering Steel Frame with Concentric Braces and soil type was considered as Medium Soil.

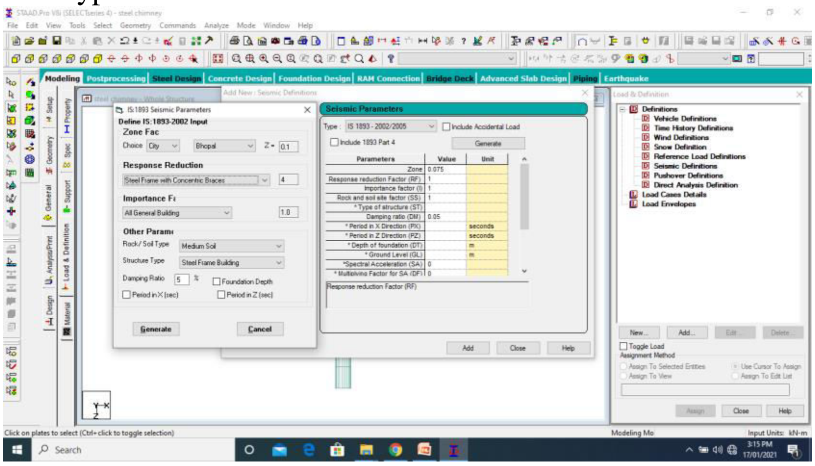


Fig 7 Assigning Seismic Loading condition as per IS :1893-2016.

Step-7 Results extracted on the models

Displacement

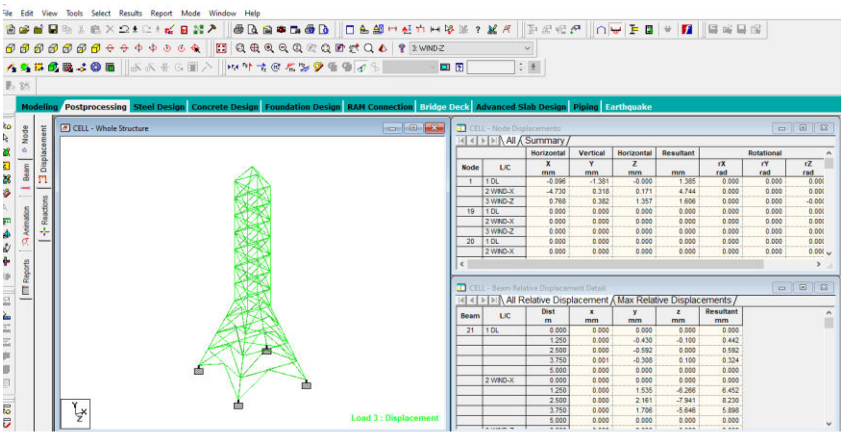


Fig8 Displacement

Bending Moment in Z Direction

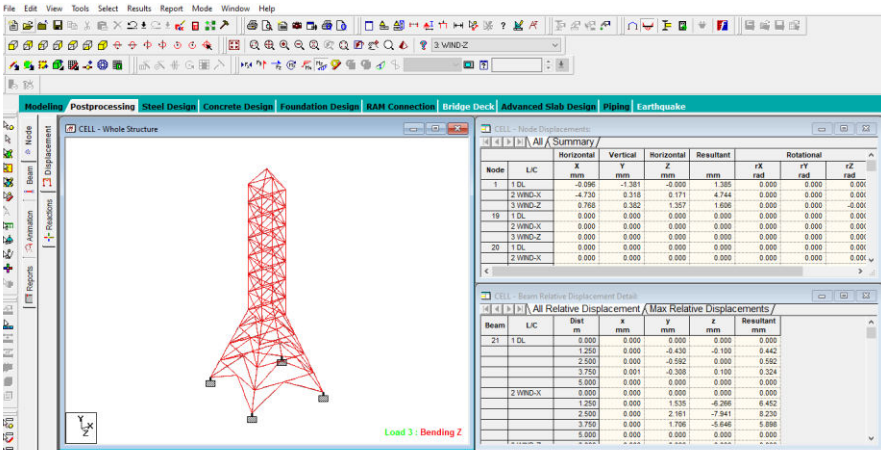


Fig9 Bending Moment in Z Direction

Bending Moment in Y Direction

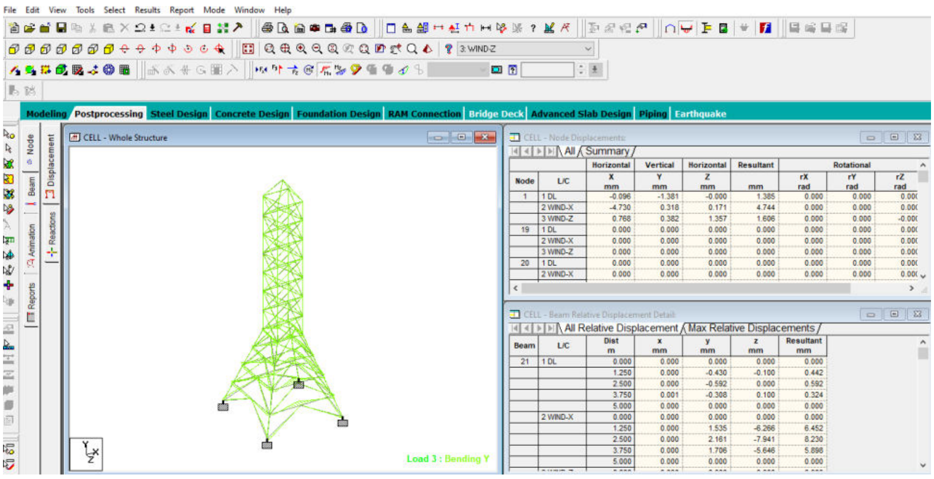


Fig 10 Bending Moment in Y Direction

Tension

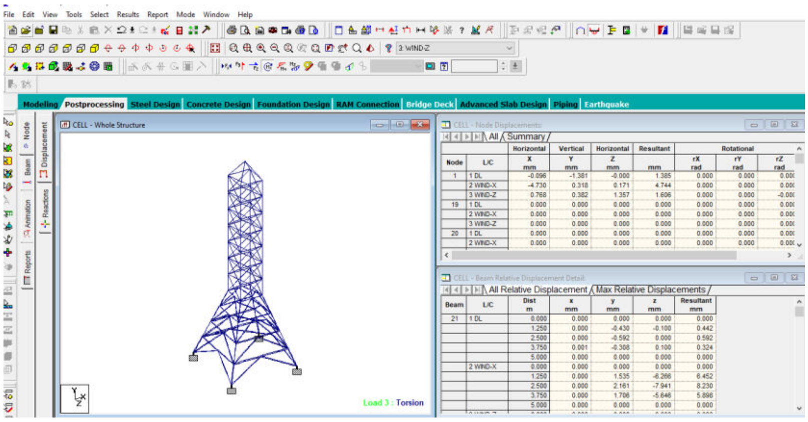


Fig11 Tension

Shear Force in Z Direction

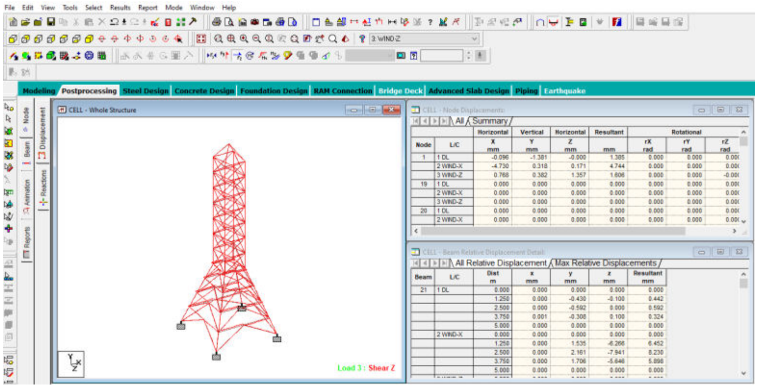


Fig 12 Shear Force in Z Direction

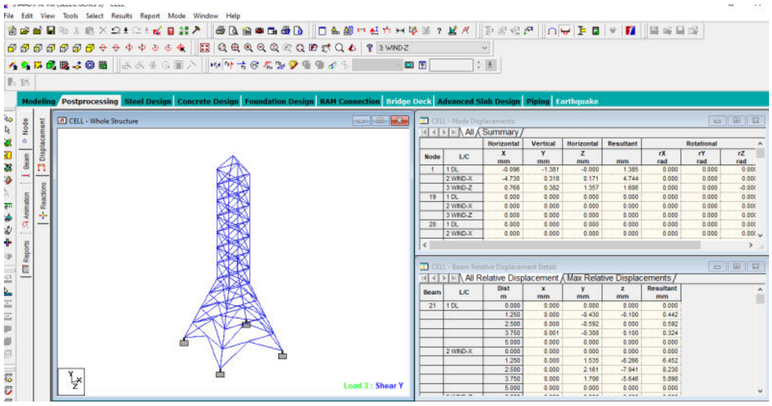
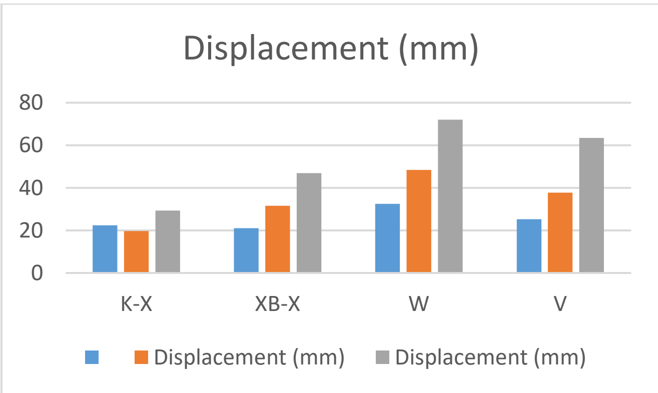


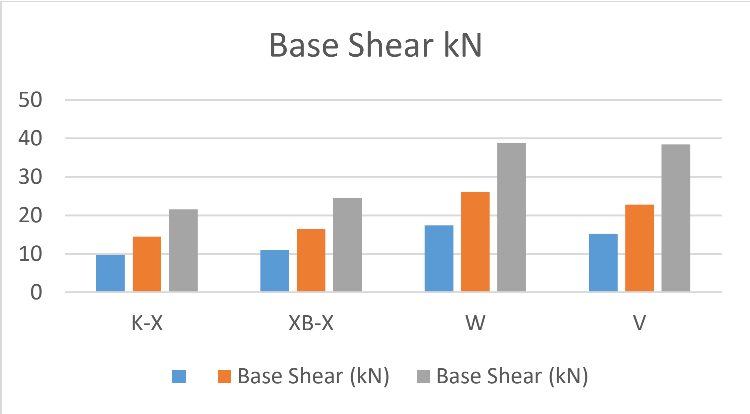
Fig 13 Shear Force in Y Direction

Step-8 Generating report of each case in Microsoft Excel for comparative analysis of the considered cases.

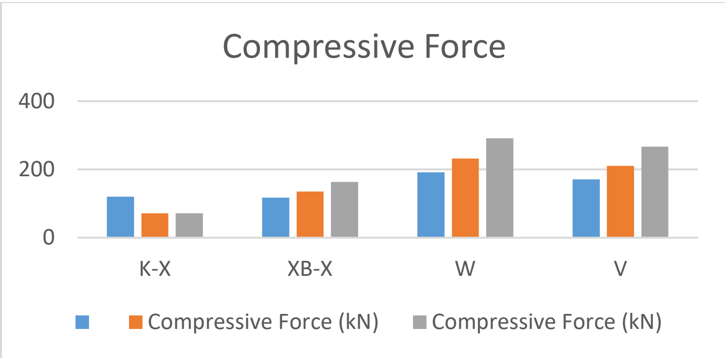
Analysis Result:



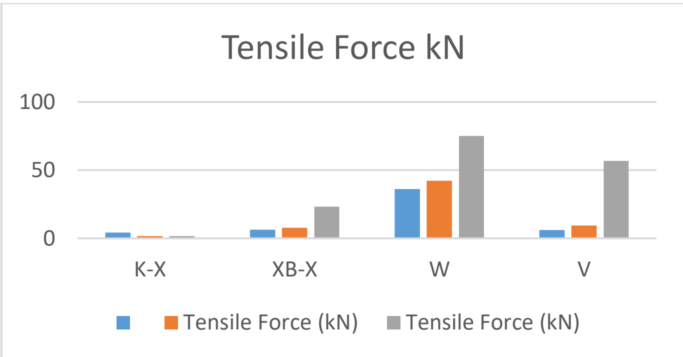
Graph 1: Displacement



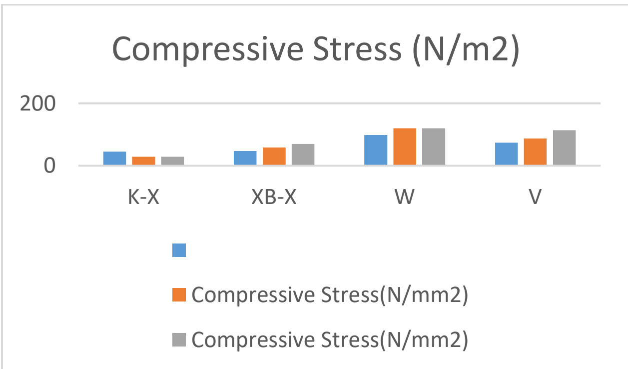
Graph 2: Base shear



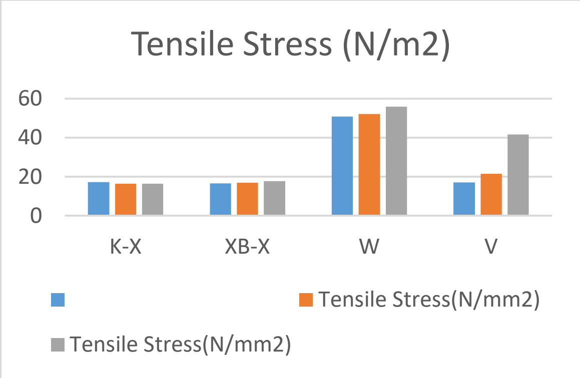
Graph 3: Compressive Force



Graph 4: Tensile Force



Graph 5 Compressive Stress (N/m^2)



Graph6 Tensile Strength

Conclusion:

TheeffectofWindandEarthquakeonTelecommunicationtowerwithfourdifferenttypesofbracingsarestudied.Thefollowingconclusionscanbedrawnbasedontheanalysisofresults.

- Fromthe wind analysis,itcanbe observed thattheincreaseinjointdisplacementofK-XbracingandW-bracing are almost same and it is 3.2% and 23.38%lesscomparedtoV-XbracingandKB-Xbracing respectively.
- ThememberforceinK-Xbracingisfoundtobeminimumand the force increase by 41%, 8.9%, and2.89% for KB-X, W-X, and V-X bracing respectivelycomparedtoK-Xbracing.
- ThestressintowerswithK-Xbracingisfoundtobelessby 51%,16%and23.5%forKB-X,W-X andV-Xbracingrespectively.
- Intheresponsespectrumanalysis,thejointdisplacementattowerlocatedinseismic zone III isfoundto be lessfortowerwithXB-Xbracing.Thedisplacements in K-X, W-X and V-X is 6.15%, 35.20%and16.89%morethanXB-Xbracingsystem.Alsotaking memberforce and stress into account, XB-Xbracingprovestobeoptimumcomparedtootherbracing system.
- InseismiczoneIVandzoneV,thejointdisplacementofK-Xbracingis37%,59%and47%lesscomparedtoXB-X,W-XandV-Xrespectively.Alsostressesdeveloped in towers with K-X bracing is less comparedtotowerswithotherbracingsystems.

Fromtheanalysisitisclearlyseenthatthewindeffectsarecritical for tower design and it is suggested to adopt K-Xbracingsystem.

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